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# Neuropsychological Effects of Posttraumatic Stress Disorder in Children and Adolescents

**Matthew R. Turley[1] and John E. Obrzut[1]**

## Abstract

Posttraumatic Stress Disorder (PTSD) can affect people of all ages but the literature is lacking on children and adolescents who experience PTSD. The consequences of this disorder extend beyond the basic symptoms by which it is defined. Neuroanatomically, the brains of children with PTSD have been found to be abnormally symmetrical in several structures, resulting in abnormal functioning. Neuropsychological assessment reveals that children and adolescents with the PTSD syndrome have significant deficits in memory, attention, executive functioning, and in overall verbal intelligence that needs to be discriminated from other syndromes with similar deficits, for example, Attention Deficit Hyperactivity Disorder (ADHD). This review presents the research findings with regard to these deficits in learning and behaviour that school psychologists encounter with students who experience PTSD. Implications for the practice of school psychology and suggestions for future research are discussed.

## Résumé

L'état de stress post-traumatique (ETPS) peut affecter des personnes de tous les âges, mais la recherche accuse un retard en ce qui concerne les enfants et les adolescents qui en sont affectés. Les conséquences de ce trouble s'étendent bien au-delà des symptômes de base qui le définissent. Du point de vue neuro-anatomique, plusieurs structures du cerveau des enfants qui en souffrent sont anormalement symétriques, ce qui entraîne un fonctionnement anormal. Une évaluation neuropsychologique révèle que les enfants et les adolescents aux prises avec ce trouble présentent des déficiences significatives en termes de mémoire, d'attention, de fonctionnement exécutif et d'intelligence

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verbale générale. Or, on retrouve d'autres syndromes avec des déficiences similaires, p. ex. le TDAH, qu'il faudrait différencier. La présente revue présente les résultats de recherches sur ces déficiences, sur les plans de l'apprentissage et du comportement que les psychologues scolaires rencontrent chez les élèves aux prises avec l'ETPS. Nous discutons de la portée des recherches visant la pratique de la psychologie scolaire et suggérons des idées pour les études à venir.

**Keywords**

posttraumatic stress disorder (PTSD), brain structure, neuropsychological functions, memory, executive functioning, attention, intelligence

## Introduction

Posttraumatic Stress Disorder (PTSD) manifests as the direct result of exposure to a traumatic stressor. Following a traumatic event, PTSD is classified by at least 1 month of involuntarily reexperiencing the event, avoiding stimuli associated with the trauma, and an increase in arousal (American Psychiatric Association, 2000). While PTSD is most often associated with war veterans, it can affect anyone ranging from adults to children in everyday settings. For children and adolescents with PTSD, the condition often results in behavioural and developmental disabilities (Fairbank, 2008). Although there are various theoretical orientations in understanding PTSD, the neuropsychological approach may be more comprehensive because it considers not only how behaviour and daily functioning is influenced by the effects of PTSD but also how brain functions and structures can affect PTSD. The impact of PTSD is typically thought of as a disorder of anxiety, but there are secondary effects that influence behaviour and cognition. A better understanding of PTSD by school psychologists might lead to more appropriate assessment and treatment of childhood PTSD symptoms that may be experienced in the classroom and/or in other social contexts. Thus this article reviews the neuropsychological effects of PTSD primarily on children and adolescents so that its impact on cognitive functioning and behaviour can be more fully understood.

## Estimated Prevalence of Childhood Onset PTSD

Although the prevalence of PTSD among children and adolescents has not been extensively researched, existing data have shown there to be a large concern for this population. For example, Kilpatrick et al. (2003) reviewed the National Survey of Adolescents to study the prevalence of PTSD. The sample of more than 4,000 adolescents (weighted to be representative of the U.S. population in terms of race, gender, age, and geographic location) indicated that criteria for PTSD were met by 4.9% of the total population. Gender differences were reported to be estimated at 6.3% of total females and 3.7% of total males.

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As could be expected, PTSD is more likely in children living in high-stress environments. Casey Family Programs (1998) reported that one of every four former foster children ($n$ = 479) had been diagnosed with PTSD. Pfefferbaum, Stuber, Galea, and Fairbrother (2006) conducted phone interviews with children who had lived in New York City during the September 11 attacks. They found that half of the participants expressed concerns about their safety and 12.6% had symptoms consistent with PTSD. Interestingly, only 5.2% of their parents met the criteria for PTSD, indicating that children may be more at risk than adults for this disorder. Thienkrua et al. (2006) studied the 2004 tsunami that struck Thailand; it is estimated that 200,000 died as a result of the disaster. Three populations were examined for PTSD: children living in camps, children living in affected communities, and children living in unaffected communities. It was found that the children who had experienced the worst trauma had the highest percentage of PTSD diagnoses while the least traumatized had the lowest (Thienkrua et al., 2006). The greater the trauma, the more likely PTSD will be developed by those who experienced it and the greater the symptoms (Fairbank, 2008).

The refugee population also has a large number of individuals with PTSD, but estimates of its prevalence are wide ranging. Recently, Bronstein and Montgomery (2011) reviewed the literature that estimated the occurrence of PTSD in refugee populations amongst people 25 years of age and younger. The data they reported found that between 19% and 54% of these young people had scores consistent with a PTSD diagnosis. In addition, data from the United States regarding the refugee populations have been reported. For example, according to the document Proposed Refugee Admissions for Fiscal Year 2012: Report to The Congress, 34.6% of 73,311 refugees, who relocated to the United States in 2010, were 17 years of age or younger (U.S. Department of State, U.S. Department of Homeland Security, & U.S. Department of Health and Human Services, 2011). Furthermore, the UN High Commissioner for Refugees (2011) estimated that Canada received 12,100 refugees in 2010. Although statistics on children in that population were not included, it stands to reason if the figure is similar to that in the United States during the same time period, it would mean that 4,189 of the refugees were 17 years of age and younger. Summarily, using the findings of Bronstein and Montgomery (2011), it can be estimated that between 5,500 and 16,000 child refugees with PTSD resettled in North America in 2010 alone.

## PTSD and Brain Structure

Although some evidence exists that abnormal brain structure is associated with PTSD, it is not clear whether there is a cause–effect relationship or whether the abnormal brain structure acts as a mediating and/or moderating influence on learning and behaviour in PTSD. One such abnormality linked with PTSD is mixed lateral dominance, which is reflective of weaker hemispheric lateralization. In the typical brain, each hemisphere is dominant for various motor and cognitive functions. An indicator that this dominance is not present is when both sides of the body are equally likely to be used to accomplish a given task. In the general population, individuals with mixed

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lateral dominance are thought to be at greater risk for developing PTSD (e.g., Boscarino & Hoffman, 2007; Chemtob, & Taylor, 2003; Spivak, Segal, Mester, & Weizman, 1998). For example, in a study consisting of 2,490 combat-exposed Vietnam veterans (Boscarino & Hoffman, 2007), 22.6% of those who were equally likely to use either hand on any given task, as assessed by the Edinburgh Handedness Inventory (EHI; Oldfield, 1971), also met the criteria for PTSD. The mixed handedness group was more than twice as likely as the rest of the sample to have PTSD (Boscarino & Hoffman, 2007). It has also been found that individuals with left-handed parents are more likely to have mixed laterality and be diagnosed with PTSD (Chemtob, & Taylor, 2003; Choudhary & Carroll, 2007). This lack of dominance allows the right hemisphere, specifically in the area of threat identification and emotion, to be more sensitive to trauma and to intrude on tasks that are processed in the left hemisphere (Spivak et al., 1998).

Chemtob, Taylor, Woo, and Coel (2001) assessed whether mixed handedness is also an indicator of vulnerability to trauma in adolescents. Study participants were all high school students who lived on the island of Kauai, Hawaii, 18 months prior when Hurricane Iniki struck the island in 1992. Handedness was determined by asking the participants to state which hand they used for writing and if they used their nonwriting hand for any other tasks. Those participants that did use their nonwriting hand for other tasks were classified as having mixed handedness. Despite the similar severity of trauma experienced between the two groups, those who were identified as displaying mixed handedness were found to have significantly higher levels of trauma and depressive symptoms.

Carrión and colleagues (e.g., Carrión, Garrett, Menon, Weems, & Reiss, 2008; Richert, Carrión, Karchemskiy, & Reiss, 2006; Saltzman, Weems, Reiss, & Carrión, 2006b) have presented further evidence concerning the relation between handedness and PTSD among young people. For example, Saltzman et al. (2006b) examined whether mixed-handed children and adolescents ($N = 59$) were more likely to have PTSD and would experience more severe symptoms compared to those with a dominant hand preference. Forty-seven percent had been diagnosed with PTSD, whereas 31% had not. Using the EHI to determine handedness and assessing PTSD symptomotology with the Clinician-Administered PTSD Scale for Children and Adolescents (CAPS-CA; Nader et al., 1996), it was determined that, similar to adults, PTSD among children and adolescents was positively related to mixed lateral preference. In addition, symptom severity was greater for those with mixed laterality regardless of PTSD diagnosis. It appears that mixed laterality is related to the symptoms of PTSD, even if the threshold for diagnosis is not met, and that these individuals are still at greater risk of being negatively affected by trauma. Carrión et al. (2001) also reported differences in brain lateralization (specifically in the frontal lobe) among children with PTSD through magnetic resonance imaging (MRI). Specifically, children with PTSD showed no significant asymmetry in the frontal lobes across hemispheres as expected. This lack of asymmetry is hypothesized to result in abnormal threat assessment and emotional functioning. Thus the abnormal asymmetry could either be a risk factor for

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PTSD development or the result of the neurotoxicity of glucocorticoids released due to stress.

Similarly, Richert et al. (2006) used MRI to examine the prefrontal cortex of children with PTSD. Analyses revealed that grey matter volume was significantly greater in middle-inferior (affecting social functioning and fear conditioning) and ventral regions (affecting social-emotional functioning and the use of reinforcement in learning) of the prefrontal cortex. Given the involvement of these regions in fear, emotions, and socialization, the association between PTSD and the abnormal formation of these regions is straight forward. Other studies (e.g., Carrión et al., 2008) used functional magnetic resonance imaging (fMRI) to examine the brain activity of adolescents when completing a task that requires response inhibition. The subjects completed the CAPS-CA to assess their PTSD symptomotology. The fMRI images were taken while the subject completed Go/No-Go tasks using block design; which was the response inhibition task. Results indicated that the brains of the PTSD children showed above average activation in the middle frontal gyrus, an area associated with response inhibition. Although the responses were of similar accuracy and speed as the control group, the brains of those children with PTSD had to work harder to get those results. Presumably, if these same brains were additionally taxed, there could be a reduction in speed and efficiency in cognitive functioning.

The structure of the superior temporal gyrus in children with PTSD was of interest to De Bellis et al. (2002a). Using MRI, findings indicated whereas the volume of grey matter in the superior temporal gyrus was greater in children with PTSD, the white matter volume in this neurological structure was smaller, such that the increase in volume was not in proportion that would be expected for normal functioning. In the posterior superior temporal gyrus, the volume of the right hemisphere was atypically larger than the left, which also has been shown to be the case in adults with high anxiety. In addition, the anterior and posterior superior temporal gyrus did not have the typical left greater than right volumetric asymmetry. In adults, this has been associated with an increased likelihood of the presence of social phobia (De Bellis et al., 2002a). Thus the structural difference seen here could be responsible for the anxiety felt in children with PTSD.

In adults with PTSD, the volume of the hippocampus has been shown to be smaller than in the average brain. This holds true for adults whose PTSD is the result of childhood trauma (Bremner et al. 2003). De Bellis, Hooper, Woolley, and Shenk (2010) used MRI to compare the hippocampal volumes of children with PTSD, traumatized children, and untraumatized children. The imaging did not show a significant difference between these groups. It is, however, possible, that there is a latency period between the occurrence of a traumatic event and a change in volume of the hippocampus. While volumetric difference was not found, it is also possible that the hippocampus of PTSD children is not functioning normally, leading to memory and verbal problems (De Bellis et al., 2010).

Children with PTSD also have been shown to have significantly smaller brain volume than those children without PTSD possibly due to the negative effects of

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stress-related neurochemicals on the brain (Carrión et al., 2001; De Bellis et al., 2002b). These neurochemicals also can cause damage to the hippocampus, an area of the brain associated with working, declarative, and episodic memory as well as verbal ability. The corpus callosum of children with PTSD also has been found to be compromised, particularly in the areas that affect memory and emotion (Jackowski, de Araújo, de Lacerda, Mari, & Kaufman, 2009).

In summary, the brains of the children and adolescents affected by PTSD are different than their peers, resulting in not only the symptoms with which the disorder is characterized but also in areas that affect other aspects of their lives. A lack of asymmetry in the brain could partially explain deficits in the verbal abilities of children as well as the presence of intrusive thoughts and attention problems. If structural abnormalities increase over the life span of the disorder, then children and adolescents experiencing PTSD would benefit from early identification and intervention before the brain is fully developed. Early intervention would not only be of benefit to the long-term well-being of the victims of trauma because of the emotional relief it might provide but also on tasks that require memory, executive functioning, and overall intelligence. Children who have experienced PTSD are likely to manifest these kinds of cognitive issues that are the basis of referrals to school psychologists.

## Specific Neuropsychological Domains and PTSD

### *Memory*

Memory problems are frequently reported in the general population of individuals with PTSD and have been found to some degree in children and adolescent populations. Moradi, Doost, Taghavi, Yule, and Dalgleish (1999a) used the Rivermead Behavioural Memory Test (RBMT; Wilson, Cockburn, & Baddeley, 1985) to compare the memory abilities of children with PTSD to a control group. The RBMT tests verbal, visual, and visuospatial memory in immediate, delayed, and prospective conditions in ways that relate to everyday life. In the control group, whereas 13.6% of participants had scores that indicated decreased memory ability, 55.6% of children with PTSD scored in the poor memory range with an additional 22.2% in the impaired memory range. In contrast, none of the children in the control group scored in that lower range. Specifically, children with PTSD had lower scores than the control group in the areas of prospective and orientation memory as well as with both delayed and immediate story recall. Prospective memory, the ability to remember to complete a task, could actually be even lower for PTSD children than the RBMT measured since the test only examines external cues and is unable to examine the internal ones. In real life situations both cues are used and may be even more difficult for individuals with PTSD. However, only the presence of PTSD rather than its severity appears to affect memory (Moradi et al., 1999a).

Yasik, Saigh, Oberfield, and Halamandaris (2007) conducted a study to examine the performance of children with PTSD on verbal memory and verbal learning tasks.

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This study compared children with PTSD to a control group that had never experienced trauma as well as a group that had experienced trauma but did not meet the criteria for PTSD. The purpose was to determine whether trauma alone could account for any memory and learning problems in children with PTSD. The authors administered the Wide Range Assessment of Memory and Learning (WRAML; Sheslow & Adams, 1990). In addition to general memory ability, the WRAML consists of three indices: verbal memory for semantic information, visual memory for visual input and recall of spatial locations, verbal list learning, and cross-modal learning. Results indicated that compared to the control group, the children with PTSD had lower scores in general memory, verbal memory, and learning. The traumatized group did not show any impairment in general memory or learning but did have lower scores than the control group in verbal memory; however, this score was significantly better in contrast to the PTSD group. Trauma exposure alone did not result in lower general memory or learning scores, nor did it fully account for the deficits observed in verbal memory (Yasik et al., 2007). Beers and De Bellis (2002) similarly found that children with PTSD have verbal memory deficits on the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987).

Samuelson, Krueger, Burnett, and Wilson (2010) compared children who had witnessed domestic violence and had developed PTSD versus those children who had not, to learn if verbal memory problems were the result of PTSD or trauma. To assess verbal memory and learning, they employed the California Verbal Learning Test–Children's Version (CVLT-C; Delis, Kramer, Kaplan, & Ober, 1994). When compared to the trauma only group, the PTSD group displayed less effective and slower learning, was more susceptible to interference, and benefited less from using rehearsal. However, the children experiencing PTSD did not show impairment in short- and long-term recall when initial learning was controlled for; indicating that the problem was not in retrieval, but in encoding (Samuelson et al., 2010). Such problems may be linked to the abnormal prefrontal cortex seen in childhood PTSD (De Bellis et al., 2002b). De Bellis et al. (2010) also examined visual memory in children with PTSD using either the Face Memory Subtest from the NEPSY (Korkman, Kirk, & Fellman, 1998) or the Rey-Osterrieth Complex Figure Delay Condition score. These authors found that greater PTSD symptomology was associated with lower visual memory as assessed by these neuropsychological measures.

The proficiency with which a traumatized adolescent remembers their own life is also diminished. Meesters, Merckelbach, Muris, and Wessel (2000) had noticed that their adolescent patients who had suffered abuse appeared to have poor autobiographical memory. To assess this, the researchers administered tests comparing verbal and autobiographical memory in a traumatized and a control group. First was a story recall test (Lezak, 1995). The researchers read the participants a neutral, short story and asked them to reproduce it twice; once immediately after it was read and again after 15 min. Participants were also administered a questionnaire that asked them to recall basic autobiographical information, such as the name of a street they used to live on, to measure semantic, autobiographical memory. While both the traumatized and

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control groups had similar scores on the story recall tasks, the traumatized group scored significantly lower on the test of autobiographical memory (Meesters et al., 2000).

Moradi, Taghavi, Neshat-Doost, Yule, and Dalgleish (2000) examined whether the emotional meaning behind words affects their ability to be remembered by children and adolescents with PTSD. The PTSD group and a control group were presented with a series of age appropriate words on a computer screen: 36 of the words were negative, 12 positive, and 12 neutral words. The negative words were divided into three groups: depression, threat, and trauma related. The participants were then shown another series of words, this time the target words were mixed with 60 additional words, all proportional to the categories used in the first list. The participants each decided if the word on the screen was in the initial list. As expected, the PTSD group recalled fewer overall words than the control subjects. Interestingly, this was the result of the PTSD group recalling fewer positive and neutral words, whereas the two groups did not differ in the recollection of negative words. Furthermore, the memories of children and adolescents were impaired, but their ability to remember negative things, such as trauma, was not affected. The authors concluded that finding is possibly related to differences in lateralization, which allows for an ever present vigilance for potential threats as indicated earlier in this review.

The consequences of childhood trauma induced PTSD on memory are not confined to one's early years. In a 2000 study, Bremner, Shobe, and Kihlstrom examined whether adult women with PTSD caused by childhood abuse had impaired memory. The study compared women with PTSD who were sexually abused as children, women who had been similarly traumatized but did not have PTSD, and a control group. Results indicated that both the control and traumatized groups were able to correctly identify the same proportion of words (61%) while the members of the PTSD group scored significantly lower (50%). In addition, the PTSD group incorrectly identified twice the number of confederate words (31%) when compared to the other groups. Women with PTSD associated with childhood trauma were more likely to falsely recall the lure words and confederate words but forget the target words; indicating that verbal memory problems were present. The inclusion of lure words suggests that the possibility for false memories is increased in this group of people (Bremner et al., 2000).

In summary, the memory deficits of children with PTSD could be the result of abnormal brain structure seen in PTSD patients, the presence of the symptoms of PTSD (such as intrusive thoughts), or a combination of both (Moradi et al., 1999a). Individuals with poor working and short-term memory have lower achievement scores. Low working memory scores were also predictive of poor reading ability (Swanson, 1994). Saigh, Mroueh, and Bremner (1997) similarly found a link between memory and achievement. With below average prospective memory, the child with PTSD will have trouble remembering to complete tasks and may have difficulty applying new information. In a classroom setting, this could be manifested by a child who fails to complete tasks and/or studying for examinations, amongst other things. Memory problems are widespread, even affecting autobiographical memories. The

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fact that the emotions connected with words affect its ability to be remembered indicates that there might be interference in the memory process. In addition, that negative and trauma-related information is remembered at a normal rate indicates that the brain might be spending additional resources to identify potential threats.

### *Executive Functioning and Attention*

The impact of PTSD on children's executive functioning and attention has also been examined from a neuropsychological perspective. For example, Beers and De Bellis (2002) administered a neuropsychological battery to both children with PTSD and a control group. In regard to attention, the PTSD group did more poorly on the Stroop Color and Word Test and the Digit Valance Test (DVT; Lewis & Rennick, 1979), indicating heightened distractibility and difficulty with visual attention. Scores on the Wisconsin Card Sorting Test (Grant & Berg, 1948) indicated that they have trouble set shifting as well as having lower abstract reasoning and problem-solving skills. This finding was also supported by the lower scores produced on the Wechsler Intelligence Scale for Children–Third Edition (WISC-III; Wechsler, 1991) similarities subtest. Furthermore, the PTSD group also did not perform as well on the Controlled Oral Word Association tests, indicating lower semantic organization ability (Benton, Hamsher, & Sivan, 1994). Finally, visual-spatial function was lower in children with PTSD, which was determined due to the greater number of errors generated in completing the Rey-Osterrieth Complex Figure Copy test (Beers & De Bellis, 2002).

Attentional bias towards information related to trauma has been observed in adults with PTSD. However, Moradi, Taghavi, Neshat-Doost, Yule, and Dalgleish (1999b) evaluated whether this effect was also present in children and adolescents with PTSD. The researchers assessed a group of children with PTSD compared with a control group on performance with a form of the Stroop color naming task. In this version, sixty age-appropriate words were shown to each participant on a computer screen. Each word was shown twice, both times in a different color. The list of words consisted of five, equally represented categories: happy, neutral, depressing, threatening, and trauma related. The word was briefly presented on the screen and the subjects were asked to indicate, by way of a microphone, the color that the word was displayed, ignoring the word itself. Results showed that the children suffering from PTSD took longer to identify the colors in general, but were especially slow when naming the colors of the words from the trauma-related list. The slowness that was found on the task as a whole was attributed to the negative impact that general anxiety exerts on processing speed. However, the PTSD symptom of hypervigilance is thought to cause an attentional bias towards trauma-related words, leading to the slower processing of those words due to perseveration (Moradi et al., 1999b). In a classroom environment, attentional problems could lead to easy distractibility that could lead to missing information and getting into trouble for not paying attention. The attentional lapses could then lead to poorer grades. There is also the potential for misdiagnosing these children with ADHD.

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DePrince, Weinzierl, and Combs (2009) wanted to learn the impact of exposure to trauma on basic executive functioning. While they did not specifically examine PTSD, exposure to trauma is a relevant component of the disorder. The researchers also wanted to know if familial trauma, trauma caused by a family member, was especially damaging to executive functioning. It was hypothesized that familial trauma would be especially damaging because of the potential for additional feelings of hopelessness and an inability to escape. As such, they compared familial trauma–exposed children with those exposed to other traumas. The arithmetic, letter-number sequencing, and digit span portions of the Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV; Wechsler, 2003) were used to assess working memory while processing speed was measured with symbol search. Behavioural inhibition, vigilance, and distractibility were assessed using the Gordon Diagnostic System (GDS; Gordon & Barkley, 1998), while attention was assessed with the Brief Test of Attention (BTA; Schretlen, Bobholz, & Brandt, 1996). Each of these scores was then combined to create a composite score for executive functioning. It was reported that individual scores of these tests and subtests, as well as the executive functioning composite, were lower in children who had experienced familial trauma. When children diagnosed with PTSD were tested, their diagnosis did not account for the lower executive functioning score (DePrince et al., 2009). In this study, trauma rather than PTSD was associated with diminished executive functioning; however, as trauma is a part of PTSD, the results apply to children and adolescents who experience the disorder.

Glod and Teicher (1996) examined the relationships among abuses experienced in childhood PTSD and Attention Deficit Hyperactivity Disorder (ADHD) in children. A group of children who had experienced abuse was compared with a control group for activity level. Each participant wore a device that monitored ambulatory activity for 3 consecutive days. It was found that the trauma exposed group was 10% more active than the control group. Some of the extra activity occurred around bedtime and after they had initially gone to sleep. Interestingly, 68% of the participants in the abused group met the diagnostic criteria for PTSD and 21% met the criteria for ADHD (all of whom also met the criteria for PTSD). The children with ADHD did not differ in activity level from the rest of the PTSD group. The PTSD children were 12.2% more active than the children in the control group; the abused children without PTSD were not significantly different than those in the control group. In addition, the younger a child was when he or she was abused correlated with a higher degree of hyperactivity and a greater chance of developing PTSD. Although the results in the study indicated a link between PTSD and ADHD, causality could not be determined according to Glod and Teicher (1996).

Wozniak et al (1999) also conducted a study to discover if there was any link between trauma, PTSD, and ADHD. These authors found that, within a family, ADHD symptomology was similar in traumatized and untraumatized children. In addition, ADHD was not a significant predictor of PTSD developing in traumatized children.

In summary, due to the fact that some of the symptoms overlap, misdiagnosing a traumatized child with ADHD rather than the more appropriate PTSD is a problem that needs to be considered by school psychologists (Weinstein, Staffelbach, &

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Biaggio, 2000). PTSD is commonly treated with intensive therapy while ADHD treatment can include behaviour modification and the use of medications; the treatments are different and their benefits are not equivalent when used inappropriately. Mistaken diagnosis and treatment with medication unnecessarily exposes these children to potential side effects such as nausea, muscle tics, dizziness, and difficulty sleeping. It is also possible that taking ADHD medication when an anxiety disorder is present can result in increased agitation, irritability, and tearfulness. There is also the loss of opportunity of taking a more appropriate, possibly effective form of treatment. Instead of possibly getting better, the child's condition could actually become more serious, resulting in greater symptoms and a need for a longer duration of therapy in the future. As ADHD assessments do not ask about possible trauma the child may have experienced, it may be appropriate for trauma to be assessed when signs of ADHD are present. It is also appropriate to pay special attention to the symptoms that occur in both PTSD and ADHD, such as inattention. Learning about the context in which such symptoms occur can provide insight into the root of the symptom. Also, asking the child what goes through his or her mind when these behaviours occur can also contextualize the problem (Weinstein et al., 2000). In our view, school psychologists are the best trained personnel in the schools to make the differential diagnosis as suggested by Weinstein et al., 2000.

Given the attentional deficits and hyperactivity that has been associated with PTSD in children, one might anticipate an overlap between their symptomology and executive functioning. Willcutt, Doyle, Nigg, Faraone, and Pennington (2005) did a meta-analysis of studies assessing executive functioning in individuals with PTSD and found that there was dysfunction in the higher order processes of inhibition, vigilance, working memory, and planning. Thus hyperactivity may be the manifestation of these executive functioning deficits.

Finally, Asbjørnsen (2010) studied language laterality in adults with PTSD using both a dichotic listening free recall task and a forced attention task. All participants were political refugees who had experienced trauma; half met the criteria for PTSD. The study reported that the participants with PTSD had a larger than normal expected right ear advantage (REA) in dichotic listening (reflective of left hemisphere processing for verbal stimuli), whereas left ear report was abnormally low, indicating a processing problem in the right hemisphere for auditory stimuli. However, the REA was simply the result of lower reporting from the left ear rather than an increase in reporting from the right ear. Theoretically, if the left hemisphere was being activated at a greater rate than usual, one would expect the right ear score to have increased, but this was not the case. Rather, the problem for PTSD subjects could be the inappropriate usage of attention in the right hemisphere that is interfering with the processing of information coming from the left ear. In addition, the scores of the left ear were correlated with self-reported feelings of depression, intrusive thoughts, and changes in arousal as these processes are associated with the right hemisphere. Although this research used adult participants, the same paradigm might be useful for diagnosing processing deficits due to attention and interference with PTSD in children as well.

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## *Intelligence*

The results of intellectual assessment in children with PTSD have been found to be mixed, indicating a complex relationship between the two (Saltzman, Weems, & Carrión, 2006a). In a study by Saigh, Yasik, Oberfield, Halamandaris, and Bremner (2006), the effects of trauma on childhood PTSD was evaluated on the WISC-III intelligence scale. The participants were divided into three groups: children with PTSD, traumatized children without PTSD, and a control group that have never experienced trauma. All participants also were given the Severity of Psychosocial Stress Scale: Children and Adolescents (SPSS-CA; American Psychiatric Association, 1987) to determine if current life stresses could account for any differences in intelligence scores. Results of the SPSS-CA indicated no significant differences between the PTSD and traumatized children. In addition, no differences were found for the age at which they were traumatized or the length of time from the initial trauma. With regard to intelligence, the children with PTSD had lower scores in Full Scale and Verbal IQ. Scores of the Verbal Comprehension index, particularly the subtests of comprehension, similarities, and vocabulary, accounted for much of the difference (Saigh et al., 2006). These subtests presumably require the ability for verbal reasoning, concept formation, memory, and conceptualization (Wechsler, 2003). The authors concluded that traumatic experiences did not account for the diminished performance seen in the children with PTSD. They theorized that the hippocampal structure of PTSD patients may account for the observed differences. Since verbal functioning is associated with the left hippocampus, a structure that has been shown to be smaller in adults with PTSD as indicated earlier in this review, it is likely that this structure also may be dysfunctional in children with PTSD (Saigh et al., 2006).

Saltzman et al. (2006a) also examined the IQ scores of children and adolescents with PTSD. The CAPS-CA was used to assess PTSD and its symptoms. To evaluate intelligence, the Wechsler Abbreviated Scales of Intelligence (WASI; Wechsler, 1999) was administered to the participants. The results showed that the total number of traumas experienced, greater frequency of reexperiencing symptoms, and impairment was negatively correlated with Full Scale IQ and Verbal IQ. Reexperiencing symptoms was significantly correlated with Verbal IQ (Saltzman et al., 2006a). Samuelson et al. (2010) also measured IQ, but used the Wechsler Intelligence Scale for Children–Fourth Edition. Children with PTSD and traumatized children were compared to a control group. Both the traumatized and PTSD groups scores placed them in the low average range. However, children with PTSD showed significant deficits in verbal memory when compared to the traumatized group (Samuelson et al., 2010). Saltzman et al. (2006a) discussed two possible explanations for the link of Verbal IQ and PTSD. The first is that a low Verbal IQ is a risk factor for PTSD. The authors postulated that a higher Verbal IQ might allow one to better process the trauma, put it into an efficacious context, and use effective coping strategies. Alternatively, low Verbal IQ might be a consequence of PTSD. Reexperiencing symptoms might fragment attention and cause performance to decrease as a result (Saltzman et al., 2006a).

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## Conclusion

This review suggests PTSD is a disorder that has consequences beyond the classic symptoms. Symptoms such as intrusive thoughts and hypervigilance translate into cognitive deficits in the functions of attention and memory. These neuropsychological deficits in turn affect higher order processing of information, resulting in lower intelligence scores. As Weems et al. (2009) discuss, treating anxiety can lower PTSD symptoms while raising grade point averages. Although Rutkowski, Proctor, Vasterling, and Anderson (2010) found that there is a potential for testing skills to also be compromised by adults with PTSD, if these results generalized to children, there could be serious consequences for them in school systems that increasingly rely on standardized testing. Understanding the consequences of PTSD can enable a school psychologist to identify the disorder in the children they work with. In cases where a child is having attention problems, knowledge of PTSD can inform the school psychologist as to whether the child has an attention problem due to ADHD or if the symptoms are related to a traumatic experience. Such appropriate identification will enable to the child to be treated appropriately and will lead to greater gains in the school setting. School psychologists with knowledge of neuropsychological principles and assessment techniques can provide greater insight into the cognitive deficits associated with this disorder and further our ability to differentially diagnose PTSD from other disorders of childhood and adolescence. Since school psychologists are primarily responsible for the assessment, placement, and treatment of children and adolescents with learning and behavioural disorders, awareness of signs, symptoms, and history of PTSD can aid in this endeavour. In addition, a larger research focus with children and adolescents who experience PTSD can begin to clarify the role that neuroanatomical structures and functions play on learning and behaviour in this diagnostic group. In so doing, the cause–effect relationships versus the role of mediating and/or moderating influence of neuroanatomical structures would be more evident.

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